

SCIENCE

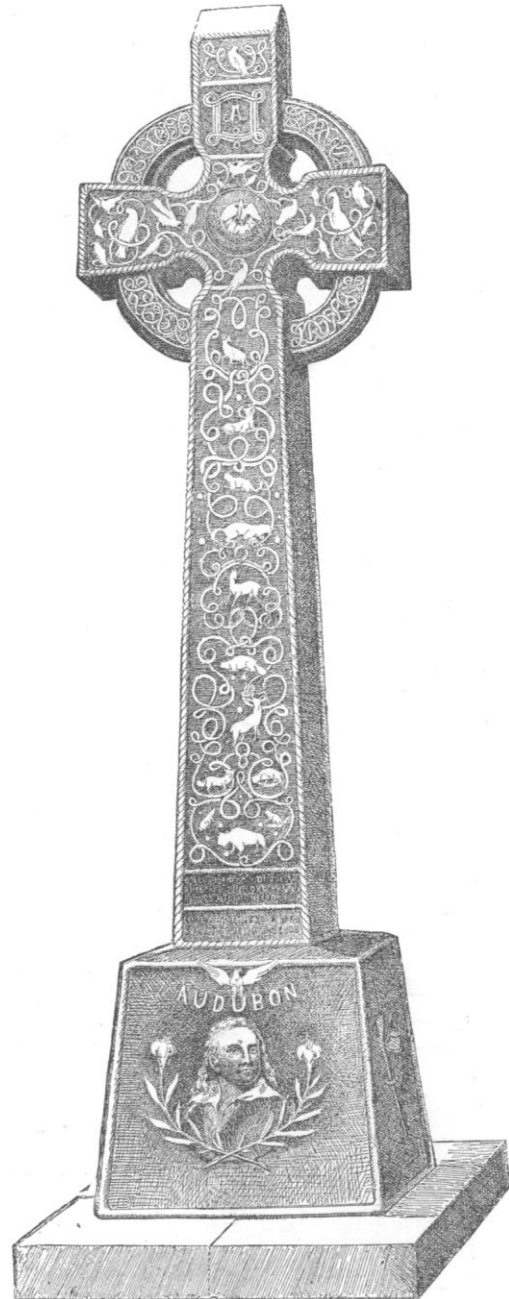
FRIDAY, APRIL 6, 1888.

IF THE AUTHORS AND PUBLISHERS could remain in Washington for a month or two, and stir up the members of Congress about once a week by way of remembrance, we believe that the international copyright bill might be passed during the present session. During the week they were there, they found friends on every side, some of them unexpected ones. The fact that all interests have been harmonized; that even the representatives of labor, whom the politicians are more afraid of than any other class of people who go to Washington with 'demands,' are satisfied, — has made a very marked impression upon Congress. We hear from Washington that the bill is very likely to pass the Senate before the adjournment, and to be reported favorably from the judiciary committee of the House. It is doubtful if the latter body, already pretty deep in the mazes of political legislation, and in less than two weeks to be wrestling with the tariff bill, and annual appropriations, and a hundred and one other topics, will have any time to devote to this measure of simple justice. The principal trouble with the international copyright bill is that there is no politics in it.

MR. G. E. GOODFELLOW'S REPORT upon the epicentral region of the Sonora earthquake, published elsewhere in this issue of *Science*, is the first connected or at all complete description of it that has yet been received in the United States. Some fragmentary and disconnected accounts by the Mexican scientific commissioners had been forwarded to the government through the State Department, but these were so meagre and disjointed as to be of very little value, except as supplementary to Mr. Goodfellow's report. The latter, prepared as it was by a gentleman who makes no pretensions to scientific expertness, is considered at the United States Geological Survey Office as a very remarkable and creditable performance. It is rare that a report is received at that office from any source, which gives evidence of so systematic, conscientious, and thorough investigation, of such perfect freedom from preconceived ideas or theories, and in which the results of an inquiry are given with so much succinctness and intelligence. Mr. Goodfellow has received many compliments at the Geological Survey Office for his excellent piece of scientific work.

THE committees in charge of the memorial to Audubon have selected a design, and are now actively engaged in endeavoring to raise the necessary funds. The committee of the New York Academy of Sciences are associated with committees of the Torrey Botanical Club, the Natural History Association of Staten Island, the Audubon Society, the American Ornithological Union, the Linnæan Society of New York, and the Manhattan Chapter of the Agassiz Association. They have so far received only a small amount of contributions, and are anxious to have the matter completed, so as to have the unveiling of the monument take place in the early fall, if possible. The design for the monument is shown in the annexed cut. It consists of a runic cross of North River bluestone, which will be eighteen feet high above the base, mounted on a pedestal which will be six feet in height. The cross will be covered on both sides with designs of the birds and animals which Audubon described, the selections being made by a special committee of the joint committees appointed for the purpose. The base will have upon one side a bas-relief of Audubon, surrounded by the Florida water-lily, which he discovered and described. On

one side will be his rifle and game-bag, he being one of the most expert shots of his time. The other face will be filled by a suitable inscription to his memory. The monument is to be placed in Trinity Cemetery, at the foot of Audubon Avenue, and will be one of the most beautiful monuments in any cemetery in New York. The effect of the relief and carving upon the North River bluestone is



such as to bring out the design, and at the same time give exactly the same effect as the ornamentation of the old runic crosses. The monument itself will cost ten thousand dollars. This does not include the erection of the vault, and the exchange of the new plot for the old one, which has been kindly undertaken by the corporation of Trinity Church. Subscriptions may be sent to Dr. Britton, Columbia College.

HELEN KELLER.

IN *Science* of Feb. 24 we gave an account of Helen Keller, a second Laura Bridgman, who, although blind and deaf, is making wonderful advances in her education. This week we give her

the first instruction to her pupil, who was then six years old. In a month the little girl learned to spell about four hundred words, and in less than three months could write a letter unaided by any one. In six weeks she mastered the Braille (French) system, which is a



HELEN KELLER AND HER TEACHER, MISS ANNIE SULLIVAN.

Dear Mr. Bell,
I am glad
to write you a letter.
Father will send
you picture. I and
Father and aunt did
go to see you in
Washington. I did
play with you
watch. I do love you.
I saw doctor in Wash-
ington. He looked at

portrait and that of her teacher, Miss Annie Sullivan, a graduate of the Perkins Institute at Boston, and also reproduce in facsimile a letter written by Helen Keller to A. Graham Bell of Washington. It was only in March, 1887, that Miss Sullivan was engaged to give

cipher for the blind, enabling them to read what they have written. She has also mastered addition, multiplication, subtraction, and geography. The illustration shows the method in which all this information has been transmitted, — solely through the sense of touch.

my eyes. I can read
 stories in my book
 I can write and spell
 and count. Good girl.
 My sister can walk
 and run. We do have
 fun with Jimbo.
 Prince is not good dog.
 He can not get birds.
 Rat did kill baby
 pigeons. Jam sorry.
 Rat does not know
 wrong. Jam mother

and teacher will go
 to Boston in June.
 I will see little Lind
 gals. Nancy will
 go with me. She is.
 a good doll. Father
 will buy me lovely
 new watch. Cousin
 Anna gave me a pretty
 doll. Her name is Allie.
 Good-bye
 Helen Keller.

SCIENTIFIC NEWS IN WASHINGTON.

Mr. Goodfellow's Report: the Locus of the *Tembler*; Description of the Great Fault; Damage to Towns; the Shaking-up of the Mountains; Fixing the Epicentral Area; Indications of Two or More Impulses; the Direction of the Wave; the Time. — Distortion in Plane-Table Sheets.

The Sonora Earthquake.

MR. GEORGE E. GOODFELLOW of Tombstone, Arizona, has just sent to Capt. C. E. Dutton, of the United States Geological Survey, a carefully prepared report on the earthquake which occurred May 3, 1887, in the south-western part of the United States and in the northern portion of Mexico. His observations were made during two journeys to the centre of disturbance in Sonora. Very little was learned by the first journey, principally because the time was wasted in searching for an alleged active volcano which had been graphically described by an imaginative correspondent of the New York *Herald*, but which never existed.

In a second trip, Mr. Goodfellow met Prof. José G. Aguilera, of the Mexican Exploring Commission, which was engaged in making a similar investigation. An arrangement was made with him by Mr. Goodfellow to exchange information; but, as he had received no report from Professor Aguilera as late as March 5 of the present year, his report is based almost exclusively upon his own observations.

After having explained why it was absolutely impossible to ascertain the time of the first shock in and about the epicentral area, and some other important data, on account of the absence of time-pieces, the illiteracy of the people and their indisposition to give facts if they had them, the sparse population and inaccessibility of the country, the absence of all means of rapid communication or transit, and, last but not least, the unparalleled severity of the rainy season of 1887, Mr. Goodfellow says, —

"The seismic movements of May 3, 1887, were felt from Toluca, capital of the State of Mexico, 26 leagues south-west from the City of Mexico, to Albuquerque or Santa Fé on the north, and from Yuma and Guaymas on the west, to a point about 60 miles east of El Paso on the east. . . . A central tract of maximum intensity, owing to superficial manifestations of ruinous energy, can be located with a considerable degree of certainty, and may be placed in the San Bernardino valley, and probably a contiguous portion of the Teras Mountains.

"The valley of the San Bernardino is a typical south-western one. It takes its name from an alleged stream, which rises near the border, in the United States, and, flowing southwards, empties into the Yaqui. These south-western valleys may be divided into three parts, — the narrow bed of the water-course; the alluvial overflow bottom; and the mesas, including the foot-hills of the encompassing mountains, for one merges into the other so rapidly, it is hard to tell where the dividing-line may be. Confining my description to the central seismic region, — the Cordilleras of Mexico, — the Sierra Madres, wherein it lies, may be said to have a general north-and-south course. The main chain is composed of numerous short ranges having a trend of 20° north or 30° west. Between each of these ranges is a pass with commonly an easterly and westerly direction, usually carrying more or less water. The valleys before described have the north-and-south direction of the bordering mountains. These mountains, varying in altitude from four thousand to ten thousand feet, are composed, for the most part, of tertiary metamorphic and eruptive rocks. In the range east of the Fronteras valley, and also east of the San Bernardino, are paleozoic strata, presumably carboniferous. The mesas are made up of more or less closely aggregated drift from the mountains. The depth of this detritus may be gauged by a description of some mesas in the neighborhood of Babispe. Between Babispe and the Madera Mountains is a mesa several miles in length which is completely isolated. The level of the river at Babispe is about 2,950 feet; and this mesa rises to the height of 4,500 feet, 1,500 feet above the altitude of the river, and is composed entirely of coarse drift. This is shown in many places by channels of lateral erosion.

"The water-courses display the usual phenomena of south-western streams, water appearing in occasional places throughout the

entire length of the bed, but a great quantity from a few inches to a few feet beneath the surface. On the eastern margin of the San Bernardino valley, where mesas merge into foot-hills, close to the steeper part of the mountains; on the mesas and in the water-courses of the valley, — are located the evidences of the severity of the earthquake. These consist of a single large fault and many minor fissures and downthrows. The former is on the base of the mountains; the latter, on the mesas and in the immediate beds of the streams. The large fault begins at the northern end of the valley, a few miles south of the line, in what is called Elias Creek, a tributary of the San Bernardino. It commences very gradually on the southern bank of the stream, increasing in width as it makes a curve towards the cañon of Los Embudos, from which point to its end the general direction of the fissure is north and south. It has a winding course, following the tortuous line of the base of the ranges in all its sinuosities to and across the Yaqui River, into the Teras Mountains some miles. Its total length, as far as followed, is about thirty-five miles." In a private letter to Captain Dutton, Mr. Goodfellow says, "In a note to *Science*, I stated that the fault was one hundred miles in length. This was a great error." He then explains that there are no good maps of Sonora and Chihuahua, save one, and that one he had not seen at the time. He was therefore obliged to judge of the length of the fissure by the time it took him to travel, and by very uncertain Mexican reports of distances. "The average difference of level between the two sides is a little over seven feet. In some places, as opposite Pitaicachi, the difference is much greater. In its entirety north of the Yaqui, it conforms to the usual law of faults by having the hanging wall the lowest; but, after passing that river some two miles, there is a place for a short distance, some two or three hundred yards, where the hanging wall is the highest. The difference in level of the portion south of the river is about three feet. At the point mentioned, where the hanging wall is elevated, the variation is a trifle more.

"The first question rising in the mind, after viewing the fissure, is, 'Is it an ideal fault, or the mere changing of the drift of the mesas by reason of alteration in subterranean reservoirs of the valley?' As favoring the first view, is the fact that it lies so near to the base of the mountains its entire length. With the structure of the valleys, before described, did it lie out on the mesas away from the foot of the Sierras, the conclusion would be almost irresistible that it is nothing more than a slip of alluvial drift, as the river-bed downthrows undoubtedly are. But, by examining closely its *locale* and characteristics, there seems a preponderance of evidence favoring the first opinion. Still there is this one thing to be recorded: nowhere in its path, as far as I saw it, can be seen an instance of the solid rock showing a participation in the fissuring, except at Pitaicachi, where a dike may be seen in the breast of the slip. This, I think, is more apparent than real. There are but three places that I saw along the line where such rents could show. These are, first, a small cañon a short distance north of Pitaicachi; second, a cañon in the Cabellera Mountains; next, at the Yaqui River. In all of these places is running water, which would have been sufficient to destroy evidence of petrous rupture. In the upper cañon, which I will call 'Elisu,' the fissure passes some three hundred feet to the west, and below a stratified mass of shaly rock which rises abruptly at this point. The approaches to these cañons are very steep; the walls at the locus mentioned being on the southern side almost vertical, on the other at an angle of at least 45°. The causes, then, of partial non-appearance of the crack on the sides of the cañon are self-evident, — the inclination is too great. In every one of the other arroyos and cañons crossed by the fissure, the bottom had as great a rent as the surface of the mesa above, and the walls were depressed proportionately to their inclination. In the Cabellera Cañon the fault is somewhat closer to the rocks, but, aside from this, the other manifestations are the same. I have no doubt that in both, at the time of the first disturbance, the alteration of level in their beds was equal to that on each side above, but the stream soon filled and levelled them. That this is the true solution of the problem, I have had ample evidence in other arroyos usually dry. In these, succeeding the rains and consequent temporary torrential flow, the break was rapidly evened, and was no more visible than in the places mentioned. At San

Rafael, where it crosses the Yaqui, the explanation is not so easy. Approaching the river from the north, until within less than a mile, the average drop is maintained. There, however, it gradually diminishes until within about three hundred feet of the stream, where it becomes simply a crack in the bluff which leads to the river-bank. On the opposite side it recommences as gradually, but never attains the old width, not exceeding in any place over five feet, and gently lessening, until at the point I abandoned it, nearly five miles south of the river, the difference in level is a foot or less. On this southern portion may be noticed two facts,—first, the course is more directly into the mountains; no longer hugging their base, it strikes directly for their heart: next, and perhaps not the least important, is the phenomenon of the hanging-wall elevation instead of depression. At the place I left off following it, a division into two occurred, the split taking place at the foot of a moderately high hill of reddish-looking metamorphic rock. Whether the fissure extends farther to the south, I cannot of my own knowledge say. From some intelligent prospectors that went into the Teras Mountains afterwards, attracted by the idea that such terrestrial commotion ought to develop some leads of mineral, and whom I asked to note any peculiarities observed, I learned that it does extend about fifteen miles more to the south. From the diminutive size of the fault where I last saw it, this seems to me improbable. It certainly is not impossible, and the statement may be taken *sub judice*. One thing is assured: the Teras Mountains have been wofully broken up; this I personally know. I have been told by Colonel Kosterlitzky, who has recently been there, that on the Chihuahua side of the Espuelas and Pitaicachi, is a duplicate of the San Bernardino fault. I have endeavored to confirm this, but without success.

“When I first viewed the end on the northern side of the river at San Rafael, it seemed certain that there was the termination of the rupture; and it was not until one of my Mexican escorts had crossed the stream, and hunted in the thick brush, that it was discovered leading up the hill. The explanation of the diminution at this place to a mere crack on each side of the river is not entirely plain to my mind: therefore I leave the problem to you for solution. The rock is indubitably involved in the slip at this point, although the drift prevents it from being seen. If it was not, there could be no faulting of even an inch, for it is not loose mesa drift, simply a slight covering with the results of cliff denudation. The solid rock shows close on both sides of the fault.

“The pass through the mountains, where the Yaqui reverses its course, is a very narrow one, three or four miles in length. The walls are perpendicular on each side, rising to the height of several hundred feet, and are composed, as are the immediate hills on the north and the mountains on the south, of some reddish-gray looking rock, probably eruptive. At the point where the river debouches from the pass, and on the last bluff on the north, the fault passes through its centre, becoming a mere crack. The pass is, or was then, impassable, though some of the Mexicans with me said they had gone through it when the river was very low: at all other times it is impossible to penetrate the gorge.

“Some things to be noticed about the fault, in connection with its sinuous course, are the small fissures at each bend with any great degree of angularity. These occur on the salients of each angle, but have no great length, in no place extending over a few hundred yards, except opposite the Cabellera Mountains, where there is a triplicate division over a mile in length. This gives the main fault the appearance of having been compressed lineally from the south, most of them having the free end to the north. They are mostly ground-throws, not simply cracks.

“From Pitaicachi to Cabellera Cañon the fault is far up on the immediate foot-hills, and subsequently crosses them where there can be no doubt as to a petrous substructure at slight depth. But, as all of them are more or less extensively covered with *débris*, I saw no spot in the face of the fault where a rent of solid rock was visible. Neither did I follow it closely through this section, owing to the weather when there. Thus I missed exploring the locality of all others which might have illustrated the point at issue. No one, however, who might stand and look over the ground at that section could doubt, that, even if nowhere else there was slipping of solid rock, here certainly there must be. A point which attracted

my attention, and which seemed significant, was the appearance of the foot-wall of the slip in many places, particularly where it abutted closely on the mountains. This was the polished surface, as if the same place had been the seat of similar perturbations in the past. At these points the drift appeared to be more thoroughly consolidated than at other localities. This striation and polishing began within a few inches of the upper margin of the wall,—a place where one would think slipping of the loosely aggregated mesa drift would cause such an appearance. In addition, the fault at these places usually was backed a short distance by the more durable portion of the mountains, generally a bluff of some extent from fifty feet to one hundred yards away. In no part of the line of greatest drop is the fall less than eight feet, while in many places it exceeds twenty. The estimated altitude of the mountains is, Guadaloupes, Espuelas, and Cabelleras, about 7,000 feet; the Teras, 9,000 to 10,000.

“This, then, is a description of the big fault. We will now consider the river-bed cracks and downthrows, for they come next in size. Beginning about the San Bernardino Ranch, at the line, these lesions exist as far as Granadas, which was as far south as I went. These ruptures are not continuous. This form is most marked about Batepito and Babispe. It is safe to say that the bed of every water-course in the San Bernardino valley has changed level relative to the mesa from six inches to two feet. This has nothing to do with the alteration of height as connected with, or caused by, the great fault: that is additional. These river-bottom dislocations seem to be a breaking-away of the bed from the enclosing mesa. The mesas composed of drift are from twenty to one hundred and fifty feet in height above the alluvial bottom, averaging perhaps fifty. The cracks begin at or within a few feet of the base of these terraces, and their course is that of the river-bed. The extent of these from San Bernardino in a direct line I have told. They also run from Bacerac to below San Miguelito, on the upper portion of the Yaqui, but are lost sight of at that point. Whether this be due to a total absence, or to the fact that the trail leads away from the river, I cannot tell; but from a short distance below San Miguel, to a crossing called ‘Pedregoso,’ I saw none, at such points as we struck the river in the line of the trail. These fords, however, were at places where the nature of the channel would have prevented any such phenomena, it being rocky and narrow. The Fronteras valley, east of the San Bernardino, but tributary to it, as may be seen by the water-course, was severely cracked up in the same manner, but in a degree not to be compared with the two first named.

“In addition to these cracks and dislocations in the valleys named, were lesions of another kind,—outbursts of sand and water through fissures and small crater-like holes, a few inches to a foot or more in diameter. This phenomenon was experienced in the Sulphur Spring and San Pedro valleys in the United States to a considerable extent, but not with the severity found farther south. At Batepito Ranch, an area two miles long by one wide was four or more inches deep with water immediately succeeding the first shock on May 3. This was the greatest quantity of water thrown up at any one place; but the total amount must have been very great, as the craters are met with wherever the river-cracks exist, and sometimes where they do not.

“The next class of fissures are simple cracks without depression existing on the mesas. None of them are, as naturally would be the case, through solid rock. They are many and extensive on the mesas of the San Bernardino valley, and have a general direction towards the main fault. Their width varies from an inch to a foot or two, usually under a foot.

“Next of the surface phenomena to be considered is the line of devastation in the mountains. Here we find millions of cubic feet of rock thrown down from the mountains to the cañons and water-courses below. Cliffs of solid crystalline rock are shattered and split, as if a charge of giant-powder had been lodged carefully amongst them for the express purpose of annihilating them. The magnitude of the quake can be appreciated more by the evidences of its force in the mountains than by the fault. The fault has the appearance, and gives the idea, that it could not be helped: it simply sunk, as Topsy grewed. But the rending and splitting of such masses as the mountain-cliffs impress one with a profound idea

and respect for the forces at work. This line of devastation will again be referred to.

"Of the towns most damaged, the principal one was Babispe. This typical little Mexican town lies on the west bank of the Yaqui or 'Babispe' River, as it is there called. The old town is situated on a terrace of the larger mesa, where the new town is. This lower mesa is about thirty feet above the river-level, and about sixty feet below the surface of the upper mesa. The composition of the mesa is, as previously indicated, loosely aggregated drift from the mountains. At this place the superficial deposit is very imperfectly consolidated. Back of the town, to the west, is the Madera range of mountains, a branch of the Teras. The range is directly to the west, and it cannot be over three or four miles away. So far as the method of Mallet in noting angles of emergence, etc., is concerned, I have this to say: there is not the slightest doubt that Mr. Mallet, or one equally as expert, could have succeeded with it, for there were plenty of fissured walls and overturned objects on which to work. There were all angles of emergence in one building,—cracks ranging from ten degrees to vertical, with several diverging branches. It seems to me that all that can be gathered out of the chaotic state of affairs is, that there has been a considerable shake-up. Apparently the buildings are very substantial, being constructed of adobes 24×12 . These are laid double, which makes all walls 24 inches in width. The average height is 8 to 10 feet; only one in the town having been greater, and that was 22 feet. The roofs are made by laying rafters, or 'vigas' as they are called, from one wall to the other; then covering these with cane, ocotilla, or brush, and that with mud, to a thickness of at least six inches. This makes an extremely heavy roof, but certainly the most suitable one for the climate. Above the vigas is built a slight coping, or fire-wall; and at intervals are openings with wooden troughs to permit the passage of rain-water. The remains of the building with the four corner posts standing are those of an exceptionally built one; and a very lucky exception it was in this case, for it saved the lives of four persons who were in it at the time.

"Of the dwellings destroyed, the major portion were on the northern and eastern side of the plaza. All walls facing the plaza on its west side whose linear direction was north and south were thrown down, falling toward the east. These were from eight to twenty feet in width, averaging probably ten feet. Of the houses on the south side of the plaza, which lie at the junction of the terrace on which the town is, with the foot of the mesa above, none were seriously damaged. They were more or less cracked, but were not prostrated. The church is the most conspicuous monument of the devastating energy of the *temblor*. It was not, perhaps, as substantial a structure as some of our slighter but more modern civilized buildings, but it certainly could lay claim to the dignity of having withstood the storms and prayers of at least two centuries.

"The destruction of life was, in my opinion, largely due to the style of architecture. The walls were not held together. In some instances I found the north-and-south walls had separated and let the vigas down into the house on one side. This involved motion of at least a foot. The walls two feet thick, viga laid to cover the entire width was obliged to slip that distance before it could drop. The horizontal cracks at the base of the walls indicated the motion. All damage was done by the first shock. The effect of subsequent tremors was visible only by psychological manifestations. Almost without exception, both sexes gave way to their terror, and devoted themselves to religious exercises for the purpose of propitiating the wrath of—so the priest said—a justly offended Deity.

"Opotu was the next town of any size to suffer considerable injury. This place lies south-west of Babispe, on the Yaqui River. It is situated on a bluff of alluvial drift on the bank of the river, some fifty feet above the stream. The axes of the two are pretty much the same as those of Babispe, almost north, south, east, and west; the population a trifle greater. There were nine people killed outright, and several others injured. I think the intensity of the shock here was fully as great as in Babispe; but the buildings did not possess the age of those in the latter place, none in Opotu being much over twenty-five years old, while none in Babispe were less than one hundred or two hundred. Perhaps this made less difference than at first sight seems possible. Owing to the manner of construc-

tion, a certain amount of repairs are constantly necessitated, which would, of course, tend to render them more stable. Of the walls thrown down, with two or three exceptions, all fell to the westward, though the upper portion of a few of the east-and-west walls had toppled over towards the south. Walls over twelve feet in length, with their linear axis east and west, suffered entirely in the east and west corners. Where they were shorter, they were thrown down, falling indifferently north or south. The characteristic damage received by all houses not prostrated was in the corners.

"In Fronteras several buildings were destroyed, and one child killed. Fronteras is just off the overflow bottom of the little stream which goes by the name of the 'Fronteras River.' The river is about three-quarters of a mile to the east of the village, and nearly on the same level. A portion of the pueblo is on an isolated drift mesa thirty to fifty feet higher than the remainder. On this mesa is where most of the damage was done. It is not over one hundred feet wide at any portion of it occupied by the houses, consequently presents facilities for amplitude of wave-motion not possessed by the lower town. The Fronteras valley is many miles in width, mesas included, and the alluvial part of it is thoroughly water-soaked. The river-bed skirts rather closely the ranges of mountains on the eastern side of the valley. The buildings of Fronteras are of great age,—one to two hundred years. San Bernardino Ranch may be considered as on the same isoseismal. Here were two buildings of adobe, presumably substantial, though slighter than the Mexican-built structures. Both were instantly prostrated at the time of the first shock, fortunately injuring no one.

"The foregoing makes up the pueblo line of maximum intensity. I wish now again to consider what I have ventured to name the mountain circle of worst disturbance, or the interior line of maximum intensity. The line of demarcation is as distinct as a street in a city. In the order in which I saw them, would be, first, the one on the trail to Babispe, south of Bedregoso. This is from one hundred to three hundred yards in width: it is difficult to tell, as the route is through a deep, narrow cañon, but through there the shattering of the rocks has been extensive. Tons have fallen into the cañons from the cliffs above. Before reaching that point, the disturbance has been moderate, and, after passing, the country has the same appearance. The next place passed having the look of equal dynamic energy was far to the south, on the range between Bacadehuachi and Granadas, about halfway, probably a trifle nearer the latter. Here identical phenomena were exhibited,—a narrow line where rocks, shaly and crystalline, have been terribly broken up. . . . On the trail from Opotu to Fronteras, between Nacosart and the Yaqui, and a little more than halfway from Fronteras to Batepito, similar phenomena were seen.

"The preceding localities form an isoseismal which I have called as above. Let me relate some of the objective symptoms which have determined my opinion in this matter. In the course of my journey, in spite of the condition of Batepito, I came to the conclusion that the epicentral area was in the Teras Mountains. The principal reason I had for this was the character of phenomena hourly occurring. During all the time I was circling that region, those mountains were continually the seat of various seismic manifestations. The principal of those was the rumbling, roaring, or, as it seemed to me, the groaning of those massive peaks. Usually this would be succeeded by a more or less severe shock; but many times the noise would be heard, lasting a minute or more, but no tremor followed. While I was in the neighborhood, certainly, all seismic disturbances had their origin from those mountains, irrespective of my situation. I had rigged up a seismograph, if such a contrivance can be entitled to the name, consisting of a bullet suspended in a large beer-bottle. This, with moderate accuracy, gave me the direction of the vibrations, and all seemed to come from the northern end of the Teras Mountains. Connecting these interior mountain-points, and erecting perpendiculars, the mean epicentrum is thrown south of the San Bernardino valley. If the Babispe, Opotu, Fronteras, and San Bernardino Ranch are joined, and the same plan pursued, the upper end begins about Pitaicachi, and the lower somewhere near the other mean.

"Admitting that the central region is about the north end of the Teras, and the southern portion of the San Bernardino valley, the

peculiarity which attracted my attention was apparently the two circles of maximum intensity, — the mountain-line, and the one indicated by the destroyed and injured towns. The solution is for you. But the thought has obtruded itself in my mind, why cannot there be areas of re-enforcement in earth as in water waves, where a succession of small impulses are followed by an aggregated one? This by reflection and accumulation of successive shocks from the focus. Of course, the point could be placed on the isoseismal of the towns, or considered as areas of characteristic epicentral disturbance.

Noteworthy is the immunity of Bacerac and San Miguel; the former nine miles south, the latter three and one-half miles to the north, of Babispe. Though the energy of the shock was undoubtedly great, no serious damage was inflicted, save to the feelings of the inhabitants; and the degree of religious frenzy originated, more than compensated for the lack of seismic perturbations. They can be put on the isoseismal of Tombstone.

"Of the effects of the *temblor*, none have been of greater interest or more importance than the modification of the water-supply of the shaken district. During the first shock, all over the area of severe and even moderate vibration, the phenomena of water-craters were exhibited. This, however, was merely a temporary affair, the flow ceasing as soon as the violent shaking was over. It is the permanent re arrangement of the water-distribution which we have to consider. Many apocryphal stories have been told of the wonderful increase of water in the Yaqui and other streams immediately succeeding the earthquake. In addition to the outpouring of the crater water, many springs were made. This latter effect was not, however, an instantaneous one. In most of the rivers and springs where there has been increase, at first they went almost dry; then in a few days or weeks was a gradual augmentation of water, this antedating the rainy season. At the present time there is an alteration in the water-supply, with others, of the following streams and springs: the rivers of Fronteras, Yaqui, and San Bernardino; the springs of Penuelas and several others with uncertain names; the arroyos of the passes, Elias, Elisu, and Cabellera. Most important is the Yaqui River. This gradually gained in volume after the first diminution, until the flow equalled its midwinter amount. The San Bernardino is now flowing from head to mouth, a thing never before known at this season of the year, and is said to be gaining. Several important springs on the eastern side of the mountains, opposite Babispe in Chihuahua, were increased in size, notably Penuelas on the Carretas Ranch. A number of entirely new springs were started. In fact, over the entire central seismic region, the water-supply has visibly augmented. In considering this, the effect of an unusually severe rainy season must be estimated.

"The rainy season of 1887 has been unequalled since 1881. There was, however, an unquestioned gain of water before this set in. But when it did come, there was nothing by which one could judge whether a specified enlarged flow was due to rain or *temblor*. The summer rainfall has been added to greatly by an extraordinary winter downpour. Altogether, there has been sufficient celestial increment to throw considerable doubt on the proximate origin of the terranean and subterranean surplus. Unlike the treasury surplus, there is no need of reduction. It is required. By reason of this extraordinary quantity of aerial moisture, the estimate of the value of the quake to the country must be held as subject to modifications in the future, should a dry season supervene, and demonstrate that the abundance of water was due to the heavens, not to the earth. One cannot contemplate the San Bernardino valley without believing that such stupendous changes as are there manifest must have caused some permanent alteration in the subterranean reservoir, — either increment or decrement. And if, at the lapse of a year, a decided increase is noted, as has been, the former result must be concluded to have taken place.

"It will be noted in all reports that the direction of the first shock is given as from west to east. This, perforce, in most instances can be nought but error, especially on the line of the railroads from Guaymas north. But let us consider the case of the Sulphur Spring valley. At the time of the primary quake a cattle round-up was going on at the station called Abbott's Ranch. The house is near the centre of the valley, which is here nearly thirty miles wide, and thoroughly waterlogged. There is no running

stream; but over its entire area water exists, from a few feet in depth on the margin, to but a few inches in the centre, which is full of swampy holes. It is a mass of alluvium, neither the mesas nor the bordering ranges on the west or east encroaching much on the margins. All reports from this place (and I have interviewed at least thirty of the one hundred or less men present when the first shock occurred) say it came from the west. The explanation I have to advance for this may or may not be a tenable one. It is this: in all earthquakes, near the central region there is what may be called a 'resonant area' preceding the vibratory movements of the earth. This, in the *temblor* of May 3, antedated the onset of the tremors a sufficiently long time to have passed to the west and north-west at the instant the shake began. Of course, the noise being in the west, the origin of the simultaneous terranean movements was of necessity located there. This, however, does not entirely answer for the Sulphur Spring valley. There they claim to have seen the rocks falling and the dust rising on the western side of the valley first, and some seconds later the same phenomena on the eastern. I am inclined to think that this is to a certain extent true. My reasons are the character and continuity of the mountain-ranges extending from the western side of the epicentral area to the western portion of the valley, and the nature of the valley itself. The rate of vibration and wave-propagation must have been modified by passing through so saturated and heterogeneous a mass as the latter. The mountains are not actually continuous between the points mentioned, but there is less breaking, therefore slighter apparent chance of interruption, on that line than any other; and it seems not an improbable or impossible hypothesis to assume that the waves, both of sound and of movement, were propagated along that line most rapidly, and did reach the western side of the valley anterior to the time they made their appearance in the east. If this be not the solution of such united testimony, it must be solved in some other way. I think the time-data indicate this view of it, though in this you must be the judge.

"Among other *sequella*, the mountain-fires which the effects of the earthquake were the sole factors in originating, were due to two causes, — falling bowlders and the emission of ignited gases. The Sierra Madre fires were, beyond question, synchronous, and arose similarly. The evidences of gaseous irruption were few but striking. Primarily were the statements of many who claim to have seen streaks of flame at different points, in the course of the first night in particular, and several times thereafter during succeeding days and nights while the heavy shocks continued. This evidence might have been a subjective sensation purely, due to inherent mendacity, or phenomena of fright similar to the stellar exhibition of syncope. The objective testimony cannot, I believe, be gainsaid. The shifting of such a tremendous mass of earth must have had some concomitant phenomena; and, if water and gas shot out to varying but moderate altitudes, why should not ignited gas do the same? It did; and the evidence was found in several places, both in the river-beds and in the hills along the line of faulting. This consisted of cinders about the margins and on the walls of the river-fissures, and the discovery of burnt branches overhanging the edges of such places, as well as the same testimony on some of the hills and mountains near the main fault.

"Anywhere near one hundred and fifty miles of the centre the energy of the shocks was considerable. All along the Sonora Railroad, from Guaymas to Nogales, and from the latter place to Benson, Tucson, El Paso, and as far north as Albuquerque, general alarm was excited. From Charleston to Benson, in the San Pedro valley, was a section of quite violent and terrifying motion. Water-tanks slopped over, cars were set in motion on the track, chimneys thrown down, buildings cracked, and water spouted up from the ground. The last-mentioned phenomenon was not exhibited north of Fairbanks. The track sank and bent at a point where it runs in an east-and-west course, about two miles west of Fairbanks. The convexity of the bend was south. These villages and stations are in the narrow, alluvial bottom of the river-course.

"At Batepito are some old adobe houses. They were frail and in ruins many years anterior to the earthquake, but it is remarkable that the remaining walls were not prostrated by the shock. Of course, some of the upper portion was broken off, and one or two having roofs crumbled in. Such structures in Babispe, Opotu,

Fronteras, or San Bernardino, would have been demolished. These houses stand in the centre of the section mentioned as having been covered with water several inches deep, and which has sunk over four feet.

"Tombstone being the nearest place where a number of time-observations could be compared, it becomes requisite to know with as great exactitude as possible the instant the shock arrived. At the onset of the *temblor* I had just noted the time, and my watch was partially in my hand in the act of returning it to my pocket. When I looked, it was 2.48 mining time, which was that day thirty-five minutes faster than standard or railroad time. When, recognizing the nature of the phenomena occurring, I again looked at my watch, just one and three-quarters minutes had elapsed. This was after the tremors had passed. The noise, resembling artillery-firing more than any thing else, continued for some seconds, dying slowly away in the north, to return in a few seconds from the south. By careful comparison and consideration of at least thirty different statements as to the Tombstone time, I am compelled to put the onset at 2.13, with a possible and probable error of ten or fifteen seconds. From Guaymas to Benson I have made personal inquiries, and think there is room for more error than in the Tombstone time. The difference in Sonora time and standard was that day thirty-four minutes.

"As concisely as possible I have tried to convey to you the facts as seen by myself, and ventured some crude notions based upon my interpretation of the observed phenomena. My idea of the explanation of the opinion that the shocks came from the west is not altogether theory. I have had the good or bad fortune to have witnessed and felt a large number of mild and severe *temblors* the past year; and if the judgment of a non-expert, based upon personal experience, be worth consideration, then the assumption is not valueless, and is worthy of your investigation."

Mr. Goodfellow's report is accompanied by maps and photographs, references to which are omitted here, as have also been some few brief passages not essential to a comprehension of the facts.

Distortion in Plane-Table Sheets.

Mr. H. G. Ogden presented to the Philosophical Society, March 17, some observations on the effects produced in a plane-table sheet by its absorption of moisture. It is well known that wetting a sheet of paper causes it to swell or expand, and that, when the sheet has dried again, it has returned to about its original dimensions. Mechanical draughtsmen have realized the errors liable to occur in their work from this cause, and have effected a partial remedy by shrinking the paper upon a board, and securing the edges to prevent further contraction, and then to provide against expansion by working in a reasonably dry air. Surveyors using the plane table resort to the same devices when executing work of great refinement, especially if they have not the check afforded by the positions of a triangulation previously plotted on the sheet. But even with a well-conditioned triangulation, unless the paper is glued to the board, the contraction is frequently the cause of great annoyance, and sometimes of error.

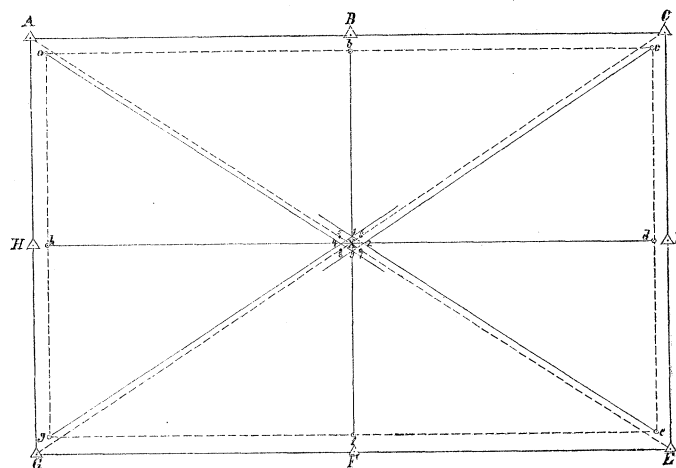
When a sheet of paper expands from moisture, the percentage of increase in length is less in the direction of the grain of the paper than at right angles to that direction, or across the grain, and the difference between these percentages is practically the distortion. If the percentage of increase should be the same in both directions, there would be only a change of scale: all distances would be proportionally increased, and the points would bear the same relations to each other as before the expansion.

While it is true that the primary cause of the distortion is the absorption of moisture, the resultant effect is usually a permanent contraction, subject only to slight changes, except under the condition of excessive moisture. It is while this point of permanent contraction is being reached that the greatest annoyance is experienced and the most serious errors are likely to occur. Mr. Ogden then described a series of experiments made at the Coast Survey office some years ago, to ascertain the changes in length that took place in the hand-made antiquarian paper backed with muslin. Inspection of these observations, when plotted in the form of a curve, shows that there was a decided tendency to assume a state of per-

manent contraction. The readings at this point for each cross-section are 35 and 26 d. c. m., or at the rate of a little over .5 d. c. m. per inch of paper in one case, and .4 d. c. m. in the other. The difference between these rates is the average distortion in this case, — a quantity that is quite appreciable in a foot of paper, and very plainly so in two feet. In field-work, Mr. Ogden said that he had frequently found the distortion double this amount, and in one instance he remembered it nearly three times as large. He had also worked a whole season without any appreciable development of distortion.

In charts or maps printed from copperplates, or by any process that required wetting the paper, this distortion is largely developed, usually averaging as great as one per cent, and, if inferior paper has been used, as much as two or three per cent. The fact that this distortion exists is frequently not realized even by the most expert navigators, and some even magnify the errors by laying off courses with a protractor, discarding the compass-cards printed with the chart. These compass-cards are affected by the contraction exactly as the sheet is: directions ascertained by them are perfectly good, but the graphic angle between any two directions is erroneous, except in the case where the directions are on the lines of contraction.

Mr. Ogden then referred to a diagram, a copy of which is given herewith. *A, B, C*, etc., were plotted in the true relations. After



the sheet has contracted, *a, b, c*, etc., represent the relations those points have assumed. The paper contracts at a uniform rate in each direction.

The table is supposed to be at *X*, the exact centre of the figure, and it is required to determine the position by the distorted points *a, b, c*, etc. By reversing the telescope, we immediately ascertain that we are directly on the line *HD*. It will also show that we are on the lines *AE, CG*, and *BF*. But the distortion is not apparent until the telescope is pointed at the signals, and the lines are drawn on the sheet. Then if we orient by the line *HD*, we shall produce the figure of the diagram, giving five determinations, 1, 2, 3, 4, and *X*, each made with four well-conditioned points. Any one of these positions would be considered satisfactory if we had not the other points to show that something was wrong. To orient by the lines *BF* will produce the same result. But if we take the diagonal *AE*, we shall have two positions at 5 and 7, formed by the intersection of the diagonal points, with the lines from the other points running wild. Using the diagonal *CG* would give two points at 6 and 8, with the lines at the other points running wild, as before.

There is no question, that, out of the nine positions developed by these settings, that at *X* is the only true compromise. When the sheet is distorted, all positions are compromises; and *X* is the true compromise in this case, for it is on the lines *GC, AE*, etc.: *a* being below, and *e* above, the line connecting *A* and *E*, by equal quantities, a line drawn between the distorted points *a* and *e* must pass through the middle point *X*. The positions 5, 6, 7, and 8 cannot be true, because the lines forming them will not pass through the

opposite points when extended, which we know to be conditions that must be filled.

The plane table is essentially a direction instrument. Theoretically we can do perfect work without knowing a single distance, and afterwards, by measuring some length between objects marked on the sheet, determine a scale for the whole. This being the case, the angle at the occupied station, between two points marked on the sheet, will be the same wherever the points may happen to be on the paper. It is the practical application of the geometric functions of similar triangles. But the distortion of a sheet destroys these perfect proportions, for we have to preserve directions between fixed objects, and knowingly increase or diminish the angle contained between the directions. As at X , we know that it is in its proper position on the line between ae , cg , etc.; but we know also that the angle aXh is smaller than it is in nature, and the angle aXc is larger.

This forcing the position does not produce any appreciable error in the work represented, as in short distances, like filling in detail around the station, the distortion cannot be measured, and in long distances it can be eliminated. It is evident that a station made by three points on the lines of contraction will give the table the true orientation, for the effect of the distortion upon three points so situated is only that of a change of scale, and a change of scale does not affect orientation. But the position of the station made in relation to the other points on the table is not true, owing to the change of scale not being the same on both lines of contraction. From the conditions presented, Mr. Ogden deduced the following rules:—

- (1) A station made with three points that are on the lines of contraction, the resecting lines forming nearly right angles at their intersection, will give the true position in relation to all points on the sheet (as h , b , and d).
- (2) A similar condition of right-angular intersection at the station, but the lines forming diagonals to the lines of contraction, will give the worst possible position for the station (as a , c , and e).
- (3) A station made with three points on one of the lines of contraction will give the correct orientation of the table (as a , h , and g).
- (4) In estimating errors of the points due to distortion, those situated on the lines of contraction require no allowance, however distant.

Mr. Ogden then explained the treatment in cases where only three points were visible,—first, when all of them are on the lines of contraction; second, when two of them are on the lines of contraction, and one of them not; and, third, when neither of them is on the lines of contraction.

The effects of distortion, as Mr. Ogden explains them, throws some light on the relative accuracy of plane-table triangulation. This class of work is good and reliable if the paper does not change its conditions; but it is evident that a triangulation extended over a sheet that has contracted since the base was plotted on it, and the first few triangles laid down upon it, will be continued on varying scales. We have but to conceive the triangles extended in the form of a parallelogram, working two sides of it from each of the separate bases to a common point, to see the theoretical outcome of such conditions.

Plane-table triangulation is liable to be further complicated by frequent changes of scale or different degrees of contraction as the work progresses, which prevent the possibility of computing the resultant errors. Some check can be obtained by subdividing the sheet into squares of uniform size, which will show, at least, how much the paper has changed when the work is finished. Such squares are an assistance in the information they give while the work is in progress; and by carefully watching the changes in them it would be possible to apply corrections for the points of a plane-table triangulation that would eliminate the worst of the errors incident to such work.

The uniformity in the contraction of a sheet of paper may also be taken advantage of in measuring the length of a diagonal line by drawing lines on the lines of contraction at right angles with each other; and, having obtained the true lengths of the two sides of the triangle, the third may be computed with at least as much accuracy as it could have been measured on the paper if the scale had not become distorted.

ELECTRICAL SCIENCE.

Alternating versus Continuous Current Distribution.

THE subject which most engrosses the attention of electric-lighting people at present, is the question of the relative values of continuous and alternating currents for electrical distribution. In England the matter was brought up by the papers of Messrs. Kapp and Mackenzie on transformers, while in this country a pamphlet issued by the Edison Company, attacking the alternating system, has been followed by two interesting papers read before the Chicago Electric Club,—one by Mr. Leonard in favor of the continuous, the other by Mr. Slatterly favoring the alternating system.

The difficulty in all of this material is that it is distinctly partisan. In spite of this, it is valuable. The trouble, of course, in getting reliable data on the subject, lies in the fact that those who have had most experience of the practical difficulties or advantages of a system are those who are directly interested in its working, and who must have some bias in its favor.

In the discussion before the Chicago Electric Club, Mr. Leonard, taking the matter up first, considers the following points: first cost, economy, reliability, value of possible sources of revenue, safety, effect on existing property. Under the first head he calculates the cost per lamp of the copper necessary for conductors in the direct system at different distances from the station: for example, with an average loss of eight per cent in the conductors, and a distance of six thousand feet, the cost is \$3.87 per lamp. With this he compares the cost of the corresponding investment in the alternating system,—copper and transformers,—and makes it \$4. This is on the assumption that copper is sixteen cents per pound. As it is principally in the cost of conductors that the alternating claims advantage over the direct system, Mr. Leonard's figures would go to prove the advantage of the latter for mean distances up to six thousand feet from the station. Passing to depreciation of the distributing plant, Mr. Leonard claims that the conductors in the direct will depreciate in value less than the conductors and converters of the rival system. The reliability of the direct system would seem greater than that of the other; for the apparatus is less complicated, and a breakdown of one engine or dynamo in a station will not affect the lights. The possible sources of revenue seem to Mr. Leonard more numerous in the continuous system. At present the alternating system can supply only light and—if it is ever needed—heat: its rival can be utilized for all the purposes to which electricity can be applied. The danger of high potential alternating currents is dwelt upon, and fatal results were cited.

Mr. Slatterly, in replying to the paper, disputes some of Mr. Leonard's points. The estimates, based on sixteen cents per pound for copper, would hardly apply to copper at nearly twenty-five cents, its present price. The alternating system has the advantage that it can be used at *any* distance from the station, and the latter can be built on inexpensive ground, not in the middle of a crowded district where property is costly. Mr. Slatterly claims for the alternating system that the accidents that have happened are due to inexperience, and their occurrence was not a fault of the system. On the question of danger he states that alternating currents are not so dangerous as continuous currents of the same potential. As regards distribution of power, Mr. Slatterly thinks that an alternating electro-motor will soon be forthcoming.

In considering electrical questions with a view of deciding between two systems, we should consider two things,—economy under present conditions, and the probable progress in the near future. As things stand at present, we may say that the direct system has the disadvantages of a limited area of distribution, and the necessity of locating in a central position, where land is expensive: the alternating system has the disadvantage of a considerably greater loss in distribution, of greater complexity and consequent liability to accident, impossibility of distributing power, and danger. These considerations would point to the direct system being best in the central portions of cities, while the alternating system should be used for towns and for the suburbs of cities; possibly, too, as an auxiliary to arc-lighting stations.

In the future the alternating system can hope for the perfection of a motor and the general improvement of the apparatus: the

direct system can hope, besides the ordinary improvements, for the perfection of some converter for direct currents; above all, for storage-batteries. If storage-batteries are successfully developed, the alternating system has nothing to offer that the direct system does not possess, while the advantages of the latter will be overwhelming. As we have already pointed out, however, a combination of the two systems would undoubtedly be best at the present moment.

ELECTRIC MOTORS FOR MINING-WORK.—Some contracts have just been completed by the Sprague Electric Motor Company that are being watched with interest by mine-owners. The most important order is for motors to be used on a circuit of about eighteen miles in length, for pumping, hoisting, etc. The river whose bed it is desired to work for gold, curves in a horseshoe shape; and a tunnel has been cut across the narrow part of the shoe, diverting the river from its bed. A turbine in the tunnel drives the generating-dynamo, while the motors are distributed along the bed of the river. Some of the other contracts are for running hoisting apparatus by motors, the power being obtained from streams distant two or three miles. There is no application of electricity with a wider field than the distribution of power, and nowhere can power be more successfully distributed by electricity than in mining-work.

FARBARKY AND SCHENCK ACCUMULATORS.—Among the numerous modifications of the Faure-Sellon-Volckmar accumulators, one of the most successful is the battery designed by Farbarky and Schenck. Originally the usual 'grid' form of support plate was used, the improvement consisting in mixing coke or other porous substance with the active material to give a better circulation of the electrolyte in the plate. Recently a change has been made in the shape of the holes in which the active material is contained. With the square hole completely filled with peroxide, there is no allowance made for its slow expansion, and the result is the 'growing' of the positive plate, with, under certain conditions, a falling-out of the plugs. In the new Farbarky-Schenck plate the solid bars are circular in form, intersecting, and leaving between the larger openings smaller, narrow slits, that allow the peroxide in the main openings to expand without causing more than a slight local strain. While it seems possible that this form of plate is an improvement on the ordinary type, yet it is hard to believe that plates made by pasting red lead or litharge into holes in lead frames can form the final type of storage-cell. In England, Germany, Austria, and this country, the Faure plan of using salts of lead mechanically applied to the support is almost universally used. In France, on the other hand, some modification of the Planté plate is usually employed, the endeavor being to form active coatings on the lead supports by the employment of an electric current, either forming the peroxide from the material of the support, or depositing it from the solution employed. At present the Faure plan is most generally used, but it is probable that the final lead storage-cell will be made by some modification of the Planté system.

THE SCHANSCHIEFF PRIMARY BATTERY.—This battery has zinc and carbon electrodes in a solution of basic sulphate of mercury and bisulphate of mercury in water. The cell has been tested by Sir W. Thomson, Mr. Preece, and others, and has been highly commended by them. The liquid can be quickly renewed when exhausted; the expense is not great; and for certain classes of work, such as mine-lamps, the lighting of trains, etc., it is said to possess advantages in weight and economy over secondary batteries.

BOOK-REVIEWS.

The Long White Mountain; or, A Journey in Manchuria. By H. E. M. JAMES. London and New York, Longmans, Green, & Co. 8°. \$6.

WE have reported several times on the interesting journey of Messrs. James, Younghusband, and Fulford in the south-eastern portions of Manchuria. A full account of this journey has now been published. The special value of the book lies in the full and concise description of the history, the inhabitants, and the religion of the province, and particularly its administration, produce, and trade. In the southern provinces the Chinese form of administra-

tion has now almost entirely superseded the Manchu, while in the province of Kirin both Chinese civil officials and Manchu military commandants are found. In the northern provinces, where Chinese immigrants are not so numerous as in southern Manchuria, the Manchu military officers still bear sway. In the region of the Long White Mountain no officials of any kind are found, but the inhabitants have formed themselves into guilds,—a very effective means of keeping their district free from brigands, which infest almost the whole province of Manchuria. The towns and villages are protected from their ravages by walls. In discussing the taxation, the author mentions the general corruption of the authorities, and gives his opinion on the opium trade. He shows that opium is grown in many parts of Manchuria, even close by the highways, although its cultivation is prohibited by law. Therefore he thinks that the raid upon the Indian opium trade is out of place, as China can supply her want of opium herself. This chapter of the book is one of the best, as the author, who is a member of the Civil Service of India, has evidently a thorough knowledge of the trade and commerce and of the production of eastern Asia. In the description of his travels, which occupies the second half of the book, particular attention is paid to the produce of each part of the province, to the methods and facilities of trade, and to the dues collected from it. He describes the roads, which are for the most part practicable only in winter, when the swamps and bogs are frozen. Even the military roads are in a poor condition. The most interesting part of the journey was that in the Ch'ang-pai-shan, the Long White Mountain, which was known from descriptions of Chinese travellers and the Jesuits, who visited it in the beginning of last century. The mountains were said to attain a height of twelve thousand feet or more, but the measurements of Younghusband show that it is only eight thousand feet high. The sources of all important rivers of Manchuria are situated in these mountains; and it must be regretted that the travellers, on account of a scarcity of supplies, were unable to make a more accurate survey of this region. The description of the inhabitants, who have formed a small republic of their own, is very interesting. We described some of the observations made by the travellers in this region in No. 245 of *Science*, according to a lecture delivered by James before the Royal Geographical Society. In the present volume he details his experiences more fully, and his report is full of interesting facts. After leaving the Long White Mountain, the travellers turned northward, and visited Tsitsihar and many other places, their travels practically covering the whole region east of the line from the Gulf of Liao-Tung to Tsitsihar. The book, which is accompanied by a good map and numerous illustrations, forms a very valuable contribution to our knowledge of the present state of affairs in Manchuria, the author giving a vivid picture of all he has seen and heard during his interesting journey.

A Manual of Analytical Chemistry, Qualitative and Quantitative, Inorganic and Organic. By JOHN MUTER. 3d ed. Philadelphia, Blakiston. \$2.

THE object of this work has been to produce a manual, short and easily understood, taking the student from the simplest to the most complex matters of qualitative analysis, and also dealing with quantitative work sufficiently to give him a fair insight into all branches of this department. It is adapted for students who desire to prepare for pharmaceutical, medical, or general university examinations in practical chemistry. The present edition has been considerably condensed in bulk, though a large amount of additional matter has been introduced. Muter's analytical chemistry has always been a popular manual with teachers and students, and the improvements in this edition will make it still more acceptable.

The Urine. Memoranda, Chemical and Microscopical, for Laboratory Use. By J. W. HOLLAND. Philadelphia, Blakiston. 12°. 50 cents.

THIS manual deserves to be generally adopted in medical schools and by physicians. It contains the latest and best tests, and is well illustrated. In addition to the tests recommended, which are both chemical and microscopical, Dr. Holland gives, under the heading 'Import,' the bearing which the result of these tests has upon the diagnosis and treatment of the patient. For instance, after describing the various tests which may be employed for the detec-

tion of urea, he says, "As urea is highly soluble, it is never spontaneously deposited. It varies in amount with different diseased conditions: e.g., in febrile and inflammatory affections it is increased in the forming stage, and diminished in that of defervescence; in diabetes mellitus and simplex it is excessive in the urine; while in acute yellow atrophy of the liver it may be entirely absent. In acute and chronic Bright's disease there may be a decided falling-off from the healthy proportion, causing a lower specific gravity. In such cases there is more or less danger of uræmia." These clinical notes are well and concisely written, and increase the value of a book which is in all other respects excellent.

NOTES AND NEWS.

DR. EMIL BESSELS, the eminent Arctic explorer, died suddenly on Saturday, March 31, at Stuttgart. His death was reported here on Monday, but not confirmed until Wednesday. He was well known to American scientists, as he lived in Washington after his return from the 'Polaris' expedition, of which he was a member. He died while in his native country, where he was about to publish a number of works.

—The incessant endeavors of the Providence Franklin Society to organize a geographical survey of the State of Rhode Island have at last been successful. The Legislature of that State has voted a sum of five thousand dollars for a topographical survey, and appointed a commission of three to contract for and superintend the work. Prof. Winslow Upton, Mr. Mills, and David W. Hoyt were appointed commissioners.

—Th. Macfarlane, in the third 'Bulletin of the Laboratory of the Inland Revenue Department of Canada,' comments upon the adulteration of coffee in Canada. Among eighty-five samples collected in various cities of Canada, only forty-four, or fifty-two per cent, were genuine, while the rest were to a greater or less extent mixed with chicory and roasted grain and peas. Among the samples occurred some described as "chiefly roasted grain with chicory and a little coffee." As these samples were bought by revenue officers, it is probable that in reality the percentage of adulterated coffee is still greater than the above figures indicate.

—Dr. Götz Martius of the University of Bonn publishes a lecture upon the aims and results of experimental psychology, in which he makes a high claim for the admittance of this science to an acknowledged place upon the curriculum of every university. The immediate occasion of the address was to arouse an interest in this line of research among the members of the university at Bonn, and to urge the establishment of a laboratory where Professor Lipps, the well-known psychologist, and himself, can have the opportunity of contributing to the advance of this growing science. There are several indications that the leading educational institutions of this country will advocate a similar department in the near future.

—The Imperial Observatory of Rio de Janeiro plans the publication of a universal dictionary of climatology. For this purpose, the director, Mr. L. Cruls, has prepared and sent out a circular soliciting information from all official and private sources as to the climatic elements of places at which observations have been or are being carried on. A table is attached to the circular, in which the results of observations are to be inserted. The mean temperatures of the months of the year, the mean maxima and minima, humidity, days and amount of precipitation, cloudiness, frequency of gales, days of frost, prevailing winds, the absolute maxima and minima, the mean annual barometric pressure, and the mean annual oscillation of the latter, are the points on which information is solicited.

—Last summer Prof. B. W. Evermann of the State Normal School, Terre Haute, and Prof. O. P. Jenkins of De Pauw University, spent their vacation at Guyamas, Mex., on the Gulf of California, collecting fishes. They packed their specimens and shipped them for home, but they did not arrive until recently, having been lost somewhere. Professors Evermann and Jenkins will arrange the collection this summer, and prepare the results of their work for publication.

—In *Science* for March 9, p. 119, 1st column, 5th line from bottom, for 'homogeneous' read 'homonymous,' for 'image' read 'images,' and for 'it' read 'they.'

LETTERS TO THE EDITOR.

Dr. Edward Tyson and the Doctrine of Descent.

ONE of the things most strongly emphasized by the recent publication of Charles Darwin's letters is his conscientious recognition of the claims of others to the first discovery of either the law of descent with variation or the principle of natural selection. The pains he took to prefix to the later editions of his work on the origin of species an historical sketch, is evidence of his earnest desire to do full justice to all previous explorers in his field. He, however, did not consider it incumbent on him to look beyond the narrow circle of those who had distinctly and explicitly expounded a doctrine of derivation. Nevertheless, for the future historian of scientific belief, the mere foreshadowings and beginnings of the modern idea of the origin of species, which Darwin set upon a firm basis of inductive proof, cannot but have an enduring interest and importance.

In this view of the matter, I feel that I may perhaps claim space in your journal to call attention to the work and writings of a man who does not seem to have been mentioned heretofore in connection with this subject, but who undoubtedly had at least a vague presentiment of the coming theory of the descent of man, derived from anatomical investigations, which, even at the present time, would probably be regarded as skilful and exact. I refer to Dr. Edward Tyson, fellow of the Royal Society and of the College of Physicians, and otherwise distinguished in his day as a man of learning and ability, who published, in 1699, his treatise entitled '*Orang-Outang, sive Homo Sylvestris; or the Anatomy of a Pygmy compared with that of a Monkey, an Ape, and a Man.*'

It is pleasing to observe in this book not only the carefulness with which Dr. Tyson traced the differences and resemblances between the parts and organs of the little monkey brought to him from Africa and the homologous parts in the higher primates, particularly man, but also the ingenuity and insight with which he drew inferences, which, if freed from the repressing influences of the seventeenth century, we can hardly doubt would have extended to the clear discernment and acceptance of the general law of development. The details of his anatomical comparisons there is not room for here; but some of his theoretical views may, I think, be referred to without exceeding proper limits.

In the first place, he seems to have perceived, though dimly, the main basis of evolution; for, amongst other similar reflections, he says, "I find there are intermediate *Species of Beings* between *Vegetables* and *Animals*, as the *Zoöphyta*; the *History* of which I could extremely desire might be given us; and can't but think that regularly in compiling a *History of Animals*, one should commence from them; and amongst these, no doubt, but that there are several degrees of Perfection, till we come to what might be properly called an *Animal*." And in another place, with still more particularity, he tells us, "Tis a true Remark, which we cannot make without Admiration; That from Minerals to Plants; from Plants to Animals; and from Animals to Men; the Transition is so gradual, that there appears a very great Similitude, as well between the meanest Plant, and some Minerals; as between the lowest Rank of Men, and the highest kind of Animals. The Animal of which I have given the Anatomy, coming nearest to Mankind; seems the Nexus of the Animal and Rational."

As if it were not enough to thus skirt along the edge of the doctrine of derivation, our author appears to have actually had a prophetic eye upon the great leader in the scientific renaissance of the nineteenth century, when he exclaims that "it would be the Perfection of Natural History, could it be attained, to enumerate and remark all the different *Species*, and their *Gradual Perfections* from one to another." And with the same irresistible impulse which Darwin possessed, to philosophize as well as observe, he further on explains with reference to his own comparative survey of his pygmy with a monkey, an ape, and a man, that, "by viewing the same Parts of all these together, we may the better observe *Nature's Gradation* in the Formation of *Animal Bodies*, and the Transitions made from one to another."

It is interesting to observe, also, that Dr. Tyson not only anticipated, in a measure, the methods and conclusions of the Darwinian period, but even, in some cases, made use of the very terms and

phrases which we have come to associate with that period alone. Thus he declares "that in this *Chain* of the *Creation*, as an intermediate Link between an *Ape* and a *Man*," he would place his pygmy. Elsewhere, however, he cautiously explains that his pygmy "is no *Man*, nor yet the *Common Ape*; but a sort of *Animal* between both; and tho' a *Biped*, yet of the *Quadrumanus-kind*; tho' some *Men* too, have been observed to use their *Feet* like *Hands*, as I have seen several." In another place he gives it as his opinion that "we may safely conclude, that *Nature* intended it a *Biped*," though he apparently feels bound to add the qualification, "yet I still think it but a sort of *Ape* and a meer *Brute*." In fact, all through his comparison he is careful to aver, that, while "our Pygmy more resembles a *Man* than *Apes* and *Monkeys* do . . . where it differs, there 'tis like the *Ape-kind*."

In the summary of the results of his dissections and comparisons, he gives tables of the particulars in which "the Orang-Outang, or Pygmy, more resembled a *Man*, than *Apes* and *Monkeys* do," and of those in which "the Orang-Outang, or Pygmy, differ'd from a *Man*, and resembled more the *Ape* and *Monkey-kind*." The points of resemblance to man he enumerates as forty-eight, and the points of difference as thirty-four. It is a curious fact that some of his points of similarity are the very ones that Darwin has made prominent by the attention which he has given to them. For example: Dr. Tyson refers to the form of the ears, in regard to which he says, "None could more resemble those of a *Man* than our Pygmy's; both as to the largeness, colour, shape, and structure. Here I observed the *Helix*, *Ant-Helix*, *Concha*, *Alvearium*, *Tragus*, *Anti-Tragus*, and *Lobus*." Like Darwin, too, he traces the rudimentary tail, of which he remarks, "The *Os Coccygis* had but four *Bones*, and these not perforated, as tis in *Man*; In *Monkeys* there are more *Bones*, and they are perforated." Darwin attaches importance to the fact "that the hair on our arms tends to converge from above and below to a point at the elbow." Dr. Tyson notices the same peculiarity, of which he remarks, "The tendency of the Hair of all the Body was downwards; but only from the Wrists to the Elbow 'twas upwards; so that at the Elbow the Hair of the Shoulder and the Arm ran contrary to one another."

In his work on the descent of man, Mr. Darwin makes the following statement: "It is notorious that man is constructed on the same general type or model with other mammals. All the bones in his skeleton can be compared with corresponding bones in a monkey, bat, or seal. So it is with his muscles, nerves, blood-vessels, and internal viscera. The brain, the most important of all the organs, follows the same law, as shown by Huxley and other anatomists. Bischoff, who is a hostile witness, admits that every chief fissure and fold in the brain of man has its analogy in that of the Orang; but he adds that at no period of development do their brains perfectly agree; nor could this be expected, for otherwise their mental powers would have been the same." And now Dr. Tyson, after comparing all the bones in man's skeleton with the corresponding bones in his monkey, and following the same process with the muscles, nerves, blood-vessels, and internal viscera, comes also to the organ of intelligence, regarding which he observes, "From what is generally received, viz. That the *Brain* is reputed the more immediate Seat of the *Soul* itself; one would be apt to think that since there is so great a disparity between the *Soul* of a *Man* and a *Brute*, the *Organ* likewise in which 'tis placed should be very different, too. Yet by comparing the *Brain* of our *Pygmy* with that of a *Man*; and, with the greatest exactness, observing each Part in both; it was very surprising to me to find so great a resemblance of the one to the other, that nothing could be more. So that when I am describing the *Brain* of our *Pygmy*, you may justly suspect I am describing that of a *Man*, or may think that I might very well omit it wholly, by referring you to the accounts already given of the *Anatomy* of an *Humane Brain*, for that will indifferently serve for our *Pygmy*, by allowing only for the magnitude of the Parts in *Man*. . . . Since therefore in all respects the *Brain* of our *Pygmy* does so exactly resemble a *Man's*, I might here make the same Reflection the *Parisians* did upon the *Organs* of *Speech*, That there is no reason to think, that *Agents* do perform such and such *Actions*, because they are found with *Organs* proper thereunto; for then our *Pygmy* might be really a *Man*. . . . But those *Nobler Faculties* in the *Mind* of *Man*

must certainly have a *higher Principle*; and *Matter* organized could never produce them; for why else, where the *Organ* is the same, should not the *Actions* be the same too; and if all depended on the *Organ*, not only our *Pygmy*, but other *Brutes* likewise, would be too near akin to us."

CHARLES F. COX.

New York, April 2.

Temperature of the Saco River.

THE monthly mean in the table is based on daily observations of the temperature of the running water at Saco, Me., at the head of the lower falls, about four miles from the mouth of the river. This river is about one hundred miles in length, and has its source in the Notch of the White Mountains of New Hampshire. Flowing nearly in a south-easterly direction, it reaches the sea in latitude $43^{\circ} 27'$, the total fall being about 1,900 feet.

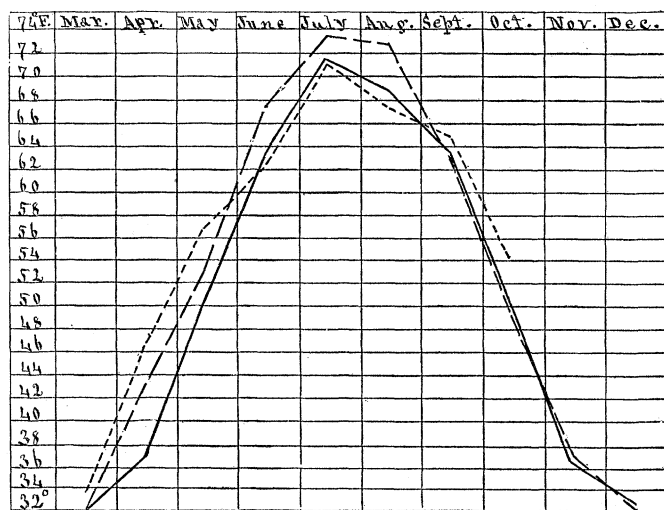
On the 9th of December, 1837, nearly the whole of the water was stopped during the night by anchor-ice, which gradually disappeared, and the full flow of the river was restored at about eleven o'clock A.M.

MEAN MONTHLY TEMPERATURE.

Year.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1837	32.00°	32.00°	32.00°	36.63°	50.19°	63.77°	71.39°	68.97°	63.53°	49.87°	36.57°	32.39°
1838	32.00	32.00	32.00	43.07	53.26	67.60	73.45	72.71	63.20	49.81	36.87	32.00
1839	32.00	32.00	33.52	46.23	56.78	62.53	71.40	67.42	64.80	54.32		

(No observations were made in November and December, 1839).

Year.	Maximum.		Minimum.		Range.	
1837	July	19	73°	Dec. 9	32°	41°
1838	"	31	76	Nov. 25	32	44
1839	"	29	76	Dec. 18	32	44



1837, SOLID LINE; 1838, BROKEN LINE; 1839, DOTTED LINE.

At a recent meeting of the British Association it was decided that observations be made on the temperature of the rivers and lakes of Great Britain. The results thus obtained will be of great value, and will depend on a great variety of causes, among which are the time of exposure to sunlight, the temperature of the earth and the air, the cooling effect of evaporation, the barometric pressure with reference to evaporation, also the effect of the wind in its direction and force, the rapid or gradual melting of snow in the valleys, the turbid or clear condition of the water as to its effect on surface radiation, the exposure of the water to the air at falls and rapids, and the length of time that the surface is covered with ice.

JOHN M. BATCHELDER.

Cambridge, Mass., March 9.